IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: **Weiser et al.**)	
)	Art Unit: **1794**
Application No.: **10/626,260**)	
)	Examiner: **Ula Corinna Ruddock**
Filing Date: **July 24, 2003**)	
)	Confirmation No.: **9583**
Title: **Turf Reinforcement Mat Having**)	
Multi-Dimensional Fibers and Method)	Atty. Docket: **05485.105053**
For Erosion Control)	

APPEAL BRIEF

Mail Stop Appeal Brief-Patents   December 5, 2008
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

Further to the Notice of Appeal filed on November 10, 2008, Appellants hereby submit this brief under 37 C.F.R. § 1.191 to appeal the Examiner's rejection of this application, as reported in the Final Office Action dated September 18, 2008 (hereinafter the "Final Office Action").

Table Of Contents

Real Party In Interest

The real party in interest is **Propex Geosolutions Corporation**, the assignee of record.

Related Appeals And Interferences

None.

Status Of Claims

Claims 1, 3-8, and 18-25 stand finally rejected and are on appeal. Claims 1 and 18 are the independent claims. Appendix 1 attached hereto provides a complete listing of Claims 1, 3-8, and 18-25.

Status Of Amendments

No additional amendments have been filed subsequent to the Final Office Action.

Summary Of Claimed Subject Matter

A turf reinforcement mat is a geotextile fabric used to prevent erosion of exposed surfaces and to facilitate the revegetation of a previously eroded surface. *See* para. 0023 of U.S. Patent Application Publication No. US 2005/0020157, a copy of which is attached hereto as Appendix 2A, corresponding to the original specification for the invention. Conventional turf reinforcement mats include round polymer monofilaments. *See* Appendix 2A, at para. 0003. Appellants' claimed invention is directed to turf reinforcement mats that include tri-lobal fibers instead of round polymer monofilaments. *See id.* at para. 0013. Each of the tri-lobal fibers has a precise geometry that is described below in connection with Appellants' independent Claims 1 and 18. As set forth in tables I-IV of the original specification, sample turf reinforcement mats including tri-lobal fibers according to Appellants' independent Claims 1 and 18 have performed significantly better in preventing erosion and promoting revegetation than conventional turf reinforcement mats including round polymer monofilaments. *See id.* at paras. 0042-0053.

Independent Claim 1 is directed to a turf reinforcement mat for supporting soil. The turf reinforcement mat includes: (1) at least one polymer net layer (*see id.* at para. 0024 and Figure 1, reference numeral 11); (2) a non-woven mat (*see id.* at para. 0024 and Figure 1, reference numeral 13) comprising a plurality of tri-lobal polymer fibers (*see id.* at paras. 0025-0026 and Figures 3 and 3A), wherein a cross-sectional geometry of respective ones of the tri-lobal polymer fibers consists essentially of: (a) a substantially circular, substantially uniform core region (*see id.*), (b) three substantially convex and smoothly curved elongated lobes substantially equally spaced about a circumference of the core region, each elongated lobe consisting of a single, substantially symmetrical half-ellipse shaped convex member disposed along a portion of the circumference of the core region, a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis defined by a shortest distance between the apex and the portion of the circumference of the core region (*see id.*), and (c) three substantially concave and smoothly curved channels separating the elongated lobes, a portion of each smoothly curved channel comprising a plurality of points along the circumference of the core region, each smoothly curved channel being configured to capture at least one of sediment and water, to break up a flow and an energy of water passing

over said soil and said mat (*see id.*); and (3) a polymer yarn stitching said net layer to said non-woven mat (*see id.* at paras. 0024 and 0028 and Figure 1, reference numeral 12). Appellants have marked Figure 3 of Appellants' original application below to illustrate one exemplary embodiment of a tri-lobal fiber having the cross-sectional geometry recited in independent Claims 1 and 18.
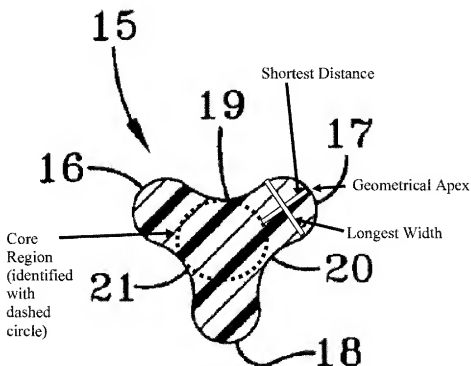

FIG-3

Independent Claim 18 is directed to a turf reinforcement mat for supporting soil. The turf reinforcement mat includes: (1) at least one polymer net layer (*see id.* at para. 0024 and Figure 1, reference numeral 11); and (2) a non-woven mat attached to said polymer net layer (*see id.* at para. 0024 and Figure 1, reference numeral 13), said non-woven mat comprising tri-lobal polymer fibers (*see id.* at paras. 0025-0026 and Figures 3 and 3A), wherein a cross-sectional geometry of respective ones of the tri-lobal polymer fibers consists essentially of: (a) a substantially circular, substantially uniform core region (*see id.*), (b) three substantially convex

and smoothly curved elongated lobes substantially equally spaced about a circumference of the core region, each elongated lobe consisting of a single, substantially symmetrical half-ellipse shaped convex member disposed along a portion of the circumference of the core region, a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis defined by a shortest distance between the apex and the portion of the circumference of the core region (*see id.*), and (c) three substantially concave and smoothly curved channels separating the elongated lobes, a portion of each smoothly curved channel comprising a plurality of points along the circumference of the core region, each smoothly curved channel being configured to capture at least one of sediment and water, to break up a flow and an energy of water passing over said soil and said mat (*see id.*).

Grounds Of Rejection To Be Reviewed On Appeal

The following issue is presented on appeal:

Whether Claims 1, 3-8, and 18-25 are obvious under 35 U.S.C. § 103(a) over U.S. Patent No. 6,855,650 to Bohannon, Jr. ("Bohannon) in view of U.S. Patent No. 5,849,645 to Lancaster ("Lancaster") and U.S. Patent No. 5,972,463 to Martin et al. ("Martin").

Argument

Claim Rejections Under 35 U.S.C. § 103(a)

The U.S. Patent and Trademark Office has the burden under 35 U.S.C. § 103 to establish a *prima facie* case of obviousness. *See* M.P.E.P. § 2141. To establish a *prima facie* case of obviousness, a single prior art reference or a combination of prior art references must render the claimed invention -- as a whole -- obvious to a hypothetical person of ordinary skill in the art at the time of the invention. *See id.* "[R]ejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." M.P.E.P. § 2142 (quoting *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006)). Such articulated reasoning must be devoid of impermissible hindsight. *See* M.P.E.P. § 2141.

I.   Independent Claims 1 And 18 Are Patentable Over The Cited Prior Art

In the Final Office Action, the Examiner rejected Claims 1, 3-8, and 18-25 under 35 U.S.C. § 103(a) as allegedly being obvious over Bohannon in view of Lancaster and Martin. Appellants respectfully traverse all of the foregoing rejections.

In particular, Appellants submit that none of the cited prior art documents, alone or in combination, disclose, teach, or suggest the combination of: (1) at least one polymer net layer; and (2) a non-woven mat comprising a plurality of tri-lobal polymer fibers, wherein a cross-sectional geometry of respective ones of the tri-lobal polymer fibers consists essentially of: (a) a substantially circular, substantially uniform core region, (b) three substantially convex and smoothly curved elongated lobes substantially equally spaced about a circumference of the core region, each elongated lobe consisting of a single, substantially symmetrical half-ellipse shaped convex member disposed along a portion of the circumference of the core region, a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis defined by a shortest distance between the apex and the portion of the circumference of the core region, and (c) three substantially concave and smoothly curved channels separating the elongated lobes, a portion of each smoothly curved channel comprising a plurality of points along the circumference of the core region, each smoothly curved channel being configured to capture at least one of sediment and water, to break

11

up a flow and an energy of water passing over said soil and said mat, as recited in each of Appellants' independent Claims 1 and 18.

A.   Bohannon

With reference to Figure 3 of Bohannon, reproduced below, Bohannon is directed to an erosion control blanket 100 formed of three layers of material. The first layer is a top sheet 120 of an open-meshed material of natural or synthetic fibers. The second layer is a loose fiber filler 140 arranged to form a three-dimensional matrix, which provides the erosion control blanket 100 with a required amount of loft or resiliency. The third layer is a bottom sheet 160 of open-meshed material that generally resembles the top sheet 120, i.e., the first layer, in construction. *See* Bohannon, at Col. 3, lines 41-50.
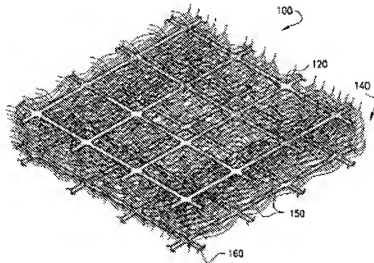

FIG. 3

The filler material 140 of the erosion control blanket 100 is an arrangement of crimped polymer fibers 150. Although the polymer fibers 150 may be arranged in various ways, Bohannon suggests randomly dispersing the fibers 150 to produce a blanket 100 with sufficient loft. In one embodiment, the polymer fibers 150 are formed of a post-consumer polyester, namely polyethylene terephthalate (PET). *See id.* at Col. 4, lines 42-52.

As admitted by the Examiner in the Final Office Action, Bohannon fails to provide any

description of the geometry and/or configuration of the cross sections of the polymer fibers 150. Therefore, Bohannon fails to disclose, teach, or suggest a non-woven mat comprising a plurality of tri-lobal polymer fibers, wherein a cross-sectional geometry of respective ones of the tri-lobal polymer fibers consists essentially of: (a) a substantially circular, substantially uniform core region, (b) three substantially convex and smoothly curved elongated lobes substantially equally spaced about a circumference of the core region, each elongated lobe consisting of a single, substantially symmetrical half-ellipse shaped convex member disposed along a portion of the circumference of the core region, a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis defined by a shortest distance between the apex and the portion of the circumference of the core region, and (c) three substantially concave and smoothly curved channels separating the elongated lobes, a portion of each smoothly curved channel comprising a plurality of points along the circumference of the core region, each smoothly curved channel being configured to capture at least one of sediment and water, to break up a flow and an energy of water passing over said soil and said mat, as presently recited in each of amended independent Claims 1 and 18. In addition, the Examiner admitted in the Office Action that Bohannon fails to disclose a polymer yarn for stitching a net layer to the non-woven mat, as recited in independent Claim 1. Accordingly, Appellants submit that Bohannon alone cannot anticipate or render obvious Appellants' claimed invention.

     B.   Lancaster

In the Final Office Action, the Examiner cited Lancaster as allegedly teaching a polyester stitching thread for securing together a bottom netting, fiber matrix, and top netting. As Appellants understand, Lancaster is directed to a reinforced composite matting. With reference to Figure 4 of Lancaster, reproduced below, the matting includes a heavy weight bottom netting 30, a fiber matrix 20, a super heavy weight cuspated netting 40, and a heavy weight top netting 50. The fiber matrix 20 preferably includes multiple strands of coconut fibers. *See* Lancaster, at Col. 4, lines 13-17.
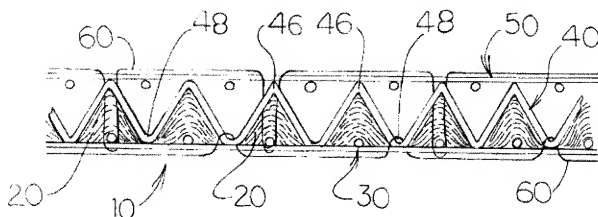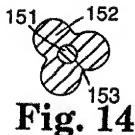
FIG. 4

The bottom netting 30, the fiber matrix 20, the cuspated netting 40, and the top netting 50 are preferably secured together by stitching strands of 60 to 100 per cent polyester black thread in spaced relation. *See id.* at Col. 5, lines 22-25. Even assuming for the sake of argument only that this thread is equivalent to the polymer yarn of Appellants' independent Claim 1, as asserted by the Examiner in the Final Office Action, Appellants submit that Appellants' claimed invention is still patentable over at least Lancaster.

Lancaster fails to provide any description of the geometry and/or configuration of the cross sections of any fibers within the matting, including the fibers in the fiber matrix 20. Therefore, Lancaster fails to disclose, teach, or suggest a non-woven mat comprising a plurality of tri-lobal polymer fibers, wherein a cross-sectional geometry of respective ones of the tri-lobal polymer fibers consists essentially of: (a) a substantially circular, substantially uniform core region, (b) three substantially convex and smoothly curved elongated lobes substantially equally spaced about a circumference of the core region, each elongated lobe consisting of a single, substantially symmetrical half-ellipse shaped convex member disposed along a portion of the circumference of the core region, a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis defined by a shortest distance between the apex and the portion of the circumference of the core region, and (c) three substantially concave and smoothly curved channels separating the elongated lobes, a portion of each smoothly curved channel comprising a plurality of points

14

along the circumference of the core region, <u>each smoothly curved channel being configured to capture at least one of sediment and water, to break up a flow and an energy of water passing over said soil and said mat</u>, as recited in each of Appellants' independent Claims 1 and 18. Accordingly, Appellants submit that Lancaster alone cannot anticipate or render obvious Appellants' claimed invention.

      C.   <u>Martin</u>

      In the Final Office Action, the Examiner cited Figure 14 of Martin, reproduced below, as allegedly disclosing multicomponent filaments of a web, wherein the filaments can have trilobal cross sections with at least three substantially concave and smoothly curved channels separating at least three substantially convex and smoothly curved lobes. As Appellants understand, Martin is directed to undrawn, tough, durably melt-bondable, macrodenier, thermoplastic, multicomponent filaments. Figure 14 of Martin illustrates a trilobal filament with a single core 151 and a single sheath 152, with a single interface 153 between the core 151 and the sheath 152. The core 151 is essentially centrally disposed within a trilobal sheath 152. *See* Martin, at Col. 13, line 64 to Col. 14, line 12.

Fig. 14

      Appellants disagree with the Examiner that the filament illustrated in Figure 14 of Martin has a cross section with at least three substantially concave and <u>smoothly curved</u> channels separating at least three substantially convex and smoothly curved lobes. Instead, Martin illustrates curved lobes separated by sharp, linear channels. Martin also illustrates a non-uniform core region that is made of multiple components. *See id.*, at Col. 13, line 55 to Col. 14, line 12. In addition, Appellants submit that Martin does not disclose, teach, or suggest at least the feature of tri-lobal polymer fibers that each have a cross-sectional geometry of consisting essentially of: (a) a substantially circular, substantially uniform core region, (b) three substantially convex and smoothly curved elongated lobes substantially equally spaced about a circumference of the core region, <u>each elongated lobe consisting of a single, substantially symmetrical half-ellipse shaped</u>

convex member disposed along a portion of the circumference of the core region, a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis defined by a shortest distance between the apex and the portion of the circumference of the core region, and (c) three substantially concave and smoothly curved channels separating the elongated lobes, a portion of each smoothly curved channel comprising a plurality of points along the circumference of the core region, each smoothly curved channel being configured to capture at least one of sediment and water, to break up a flow and an energy of water passing over said soil and said mat, as recited in each of Appellants' independent Claims 1 and 18.

Appellants have marked Figure 3 of Appellants' original application below to illustrate one exemplary embodiment of a tri-lobal fiber having this cross-sectional geometry.
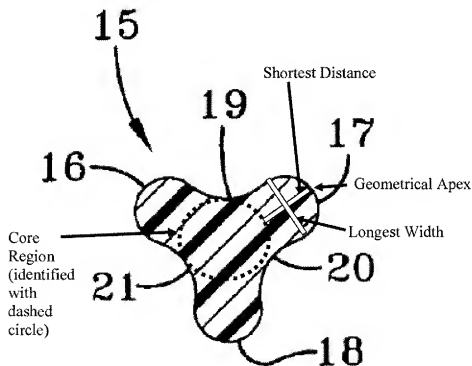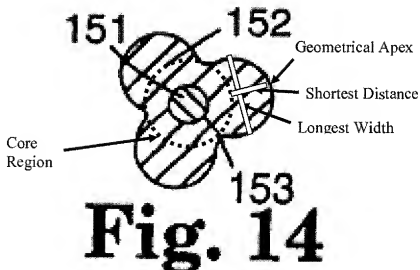

FIG-3

With reference to Figure 14 of Martin, Appellants note that the lobes of the sheath 152 of Martin are round, rather than <u>elongated</u> and substantially symmetrical half-ellipse shaped, and that each of the alleged "channels" between the lobes does not include a plurality of points along the circumference of a <u>substantially uniform</u> core region. Even assuming for the sake of argument only that the core 151 of Martin can be equated with Appellants' claimed "core region," each of the "channels" between the lobes of Martin does not include a plurality of points along the circumference of the core 151.

In addition, as illustrated in the below marked version of Figure 14 of Martin, for each of the lobes of the sheath 152 of Martin, a shortest distance between a geometrical apex of the lobe and a portion of a circumference of a core region along which the lobe is disposed is not substantially equal to a longest width of the lobe along a geometrical axis perpendicular to a geometrical axis defined by the shortest distance between the geometrical apex and the portion of the circumference of the core region. Rather, the longest width of the lobe of Martin is larger than the shortest distance between the geometrical apex of the lobe and a portion of a circumference of a core region along which the lobe is disposed.

Fig. 14

Further, as noted above, Martin also teaches that his filaments are multi-component in nature. Specifically, Martin teaches a non-uniform core region made of at least two components

17

151 (core) and 152 (sheath). Therefore, Martin fails to disclose, teach, or suggest a non-woven mat comprising a plurality of tri-lobal polymer fibers, wherein a cross-sectional geometry of respective ones of the tri-lobal polymer fibers consists essentially of: (a) a substantially circular, substantially uniform core region, (b) three substantially convex and smoothly curved elongated lobes substantially equally spaced about a circumference of the core region, each elongated lobe consisting of a single, substantially symmetrical half-ellipse shaped convex member disposed along a portion of the circumference of the core region, a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis defined by a shortest distance between the apex and the portion of the circumference of the core region, and (c) three substantially concave and smoothly curved channels separating the elongated lobes, a portion of each smoothly curved channel comprising a plurality of points along the circumference of the core region, each smoothly curved channel being configured to capture at least one of sediment and water, to break up a flow and an energy of water passing over said soil and said mat, as presently recited in each of amended independent Claims 1 and 18.

In the Final Office Action, the Examiner admitted this deficiency of Martin, stating, "Bohannon, Jr., Martin et al, and Lancaster fail to disclose the specific fibrous structure set forth in the claims." *See* Office Action, at page 4. However, the Examiner asserted that "it would have been obvious to one having ordinary skill in the erosion control art to have made a fiber having the claimed specific fibrous structure, motivated by the desire to create an erosion control mat with increased moisture transport ability." *See id.* Although Appellants agree that Bohannon, Martin, and Lancaster fail to disclose the specific fibrous structure set forth in the claims, Appellants disagree that it would have been obvious to one having ordinary skill in the erosion control art to have made a fiber having that structure. In particular, Appellants believe that the Examiner's position with regard to this structure is not founded in evidence but, rather, on hindsight gleaned from the present application. Moreover, the Examiner's position summarily dismisses Appellants' invention without considering each of Appellants' specific claim limitations, such as a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis

defined by a shortest distance between the apex and the portion of the circumference of the core region, and without articulating a rational underpinning as to why each of these specific claim limitations is obvious in view of the cited prior art, as required by M.P.E.P. §§ 2142 and 2143.03.

Appellants submit that a person of ordinary skill in the art at the time of Appellants' invention would not have been motivated by Martin to make a fiber having Appellants' claimed specific fibrous structure. As Appellants understand, Martin is primarily directed to flooring mats and abrasives and discloses eleven different cross-sectional fiber shapes (in Figures 7-17) of which only one remotely approximates the shape of the fiber of the claimed invention. Martin fails to disclose, teach, or suggest any reason why that particular shape would be more desirable than the other disclosed shapes in an erosion control application. In addition, Martin, fails to disclose, teach, or suggest any reason why a person of ordinary skill in the art at the time of Appellants' claimed invention would have modified that particular shape to have the specific fibrous structure recited in Appellants' claims.

In the Final Office Action, the Examiner asserted that a person of ordinary skill in the art would have made such a modification based on a desire to "create an erosion control mat with increased moisture transport ability." *See* Office Action, at page 4. Appellants respectfully disagree. As recited in each of Appellants' independent Claims 1 and 18, the purpose of Appellants' turf reinforcement mat is to support soil using fibers that capture sediment and/or water. The fibers also break up a flow and energy of water passing over the soil and mat.

Therefore, Appellants submit that the Examiner has failed to establish a *prima facie* case of obviousness with respect to Appellants' independent Claims 1 and 18. Accordingly, Appellants respectfully request withdrawal of the rejections of these claims.

II.   Dependent Claims 3-8 And 19-25 Are Patentable Over The Cited Prior Art

Each of Claims 3-8 and 19-25 depends directly or indirectly from one of the independent claims discussed above. Accordingly, for at least the reasons discussed above with respect to the independent claims, Appellants submit that the dependent claims are likewise patentable over at least Bohannon, Lancaster, and Martin. The dependent claims also recite additional features that further define the claimed invention over Bohannon, Lancaster, and Martin. Accordingly, Appellants request separate and individual consideration of each dependent claim.

Conclusion

No fees are believed to be due in connection with the submission of this Appeal Brief. The Commissioner is authorized to charge any underpayment of fees to King & Spalding Deposit Account No. 11-0980.

In view of the arguments presented herein, Appellants respectfully request that the final rejection in this matter be reversed, and that this application be returned to the Examiner with instructions to enter a notice of allowance for pending Claims 1, 3-8, and 18-25.

Respectfully submitted,

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APPENDIX 1

CLAIMS APPENDIX

1.   (Previously Presented) A turf reinforcement mat for supporting soil, comprising:

at least one polymer net layer;

a non-woven mat comprising a plurality of tri-lobal polymer fibers, wherein a cross-sectional geometry of respective ones of the tri-lobal polymer fibers consists essentially of:

   a substantially circular, substantially uniform core region,

   three substantially convex and smoothly curved elongated lobes substantially equally spaced about a circumference of the core region, each elongated lobe consisting of a single, substantially symmetrical half-ellipse shaped convex member disposed along a portion of the circumference of the core region, a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis defined by a shortest distance between the apex and the portion of the circumference of the core region, and

   three substantially concave and smoothly curved channels separating the elongated lobes, a portion of each smoothly curved channel comprising a plurality of points along the circumference of the core region, each smoothly curved channel being configured to capture at least one of sediment and water, to break up a flow and an energy of water passing over said soil and said mat; and

a polymer yarn, stitching said net layer to said non-woven mat.

2.   (Canceled)

3.   (Previously Presented) The turf reinforcement mat of claim 1, wherein each of said tri-lobal polymer fibers is selected from the group consisting of polyolefins, polyesters, polyamides and blends thereof.

4.   (Previously Presented) The turf reinforcement mat of claim 1, wherein each of said tri-lobal fibers has a length from about 2 inches (5 cm) to about 12 inches (30 cm).

5.   (Previously Presented) The turf reinforcement mat of claim 1, wherein each of said tri-lobal polymer fibers has a density of from 300 denier (333 decitex) to about 2000 denier (2222 decitex).

6.   (Previously Presented) The turf reinforcement mat of claim 5, wherein each of said tri-lobal polymer fibers has a density of from 500 denier (555 decitex) to about 1100 denier (1222 decitex).

7.   (Previously Presented) The turf reinforcement mat of claim 1, wherein the polymer of said net layer is selected from the group consisting of polyolefins, polyesters, polyamides and blends thereof.

8.   (Previously Presented) The turf reinforcement mat of claim 1, further comprising a second polymer net layer, said non-woven mat being located between said first and second net layers.

9-17. (Canceled)

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18.   (Previously Presented) A turf reinforcement mat for supporting soil, comprising:

at least one polymer net layer; and

a non-woven mat attached to said polymer net layer, said non-woven mat comprising tri-lobal polymer fibers, wherein a cross-sectional geometry of respective ones of the tri-lobal polymer fibers consists essentially of:

a substantially circular, substantially uniform core region,

three substantially convex and smoothly curved elongated lobes substantially equally spaced about a circumference of the core region, each elongated lobe consisting of a single, substantially symmetrical half-ellipse shaped convex member disposed along a portion of the circumference of the core region, a shortest distance between a geometrical apex of the convex member and the portion of the circumference of the core region being substantially equal to a longest width of the convex member along a geometrical axis perpendicular to a geometrical axis defined by a shortest distance between the apex and the portion of the circumference of the core region, and

three substantially concave and smoothly curved channels separating the elongated lobes, a portion of each smoothly curved channel comprising a plurality of points along the circumference of the core region, each smoothly curved channel being configured to capture sediment and water, to break up a flow and an energy of water passing over said soil and said mat.

19.   (Previously Presented) The turf reinforcement mat of claim 18, wherein each of said tri-lobal polymer fibers is selected from the group consisting of polyolefins, polyesters, polyamides and blends thereof.

20.   (Previously Presented) The turf reinforcement mat of claim 18, wherein each of said tri-lobal fibers has a length from about 2 inches (5 cm) to about 12 inches (30 cm).

21.   (Previously Presented) The turf reinforcement mat of claim 18, wherein each of said tri-lobal polymer fibers has a density of from 300 denier (333 decitex) to about 2000 denier (2222 decitex).

23.   (Previously Presented) The turf reinforcement mat of claim 21, wherein each of said tri-lobal polymer fibers has a density of from 500 denier (555 decitex) to about 1100 denier (1222 decitex).

24.   (Previously Presented) The turf reinforcement mat of claim 18, wherein the polymer of said net layer is selected from the group consisting of polyolefins, polyesters, polyamides and blends thereof.

25.   (Previously Presented) The turf reinforcement mat of claim 18, further comprising a second polymer net layer, said non-woven mat being located between said first and second net layers.

26.   (Canceled).

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APPENDIX 2

EVIDENCE APPENDIX

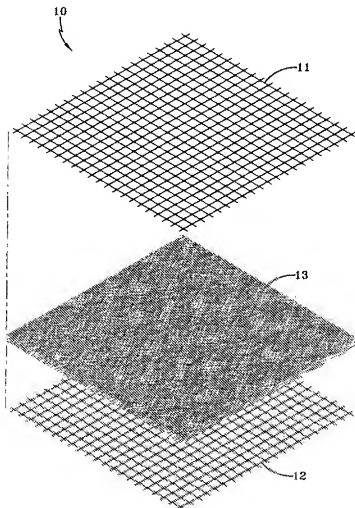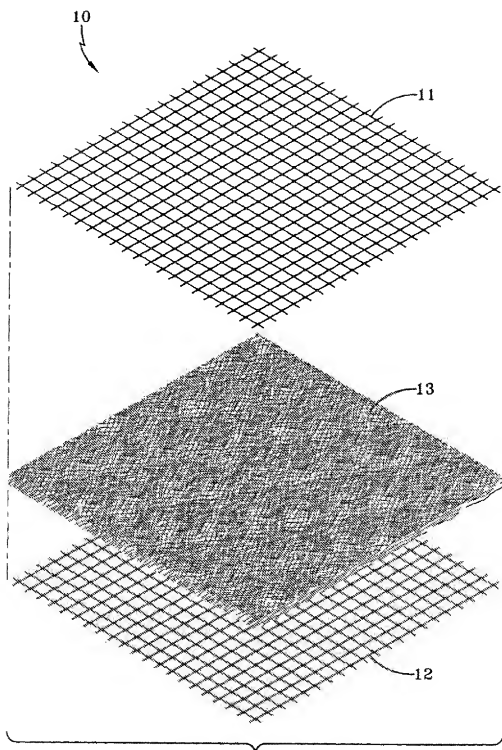Appendix 2A: Copy of Appellants' U.S. Patent Application Publication No. US 2005/0020157

APPENDIX 2A

(19) **United States**

(12) **Patent Application Publication** (10) Pub. No.: US 2005/0020157 A1
Weiser et al. (43) Pub. Date: Jan. 27, 2005

(54) **TURF REINFORCEMENT MAT HAVING MULTI-DIMENSIONAL FIBERS AND METHOD FOR EROSION CONTROL**

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B32B 5/26

(52) U.S. Cl. 442/49; 442/35; 442/32

(57) **ABSTRACT**

A turf reinforcement mat (10) comprises at least one polymer net layer (11); a non-woven mat (13) comprising a plurality of multi-dimensional polymer fibers (15); and, a polymer yarn (80, 81), stitching the net layer to the non-woven mat. A method for erosion control and revegetation facilitation comprises providing a turf reinforcement mat comprising at least one polymer net layer; a non-woven mat comprising a plurality of multi-dimensional polymer fibers; and, a polymer yarn, stitching the net layer to the non-woven mat; laying the turf reinforcement mat on a section of ground to be reinforced; securing the turf reinforcement mat to the ground; distributing soil and seed onto the turf reinforcement mat such that the section of ground is quickly revegetated and thereby protected from further erosion.

10

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13

12

FIG-1

FIG-2

FIG-3A

FIG-3

FIG-4

FIG-5

FIG-6

TURF REINFORCEMENT MAT HAVING MULTI-DIMENSIONAL FIBERS AND METHOD FOR EROSION CONTROL

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] None

BACKGROUND OF THE INVENTION

[0002] Broadly, this invention relates to turf reinforcement mats. Turf reinforcement mats, or TRM's promote revegetation, provide erosion protection and improve water quality on slopes and in channels. More specifically, the present invention relates to the polymer fiber filler material used in the construction of a permanent turf reinforcement mat. The polymer filler employed has multidimensional fiber cross sections.
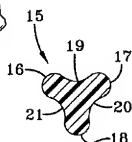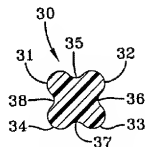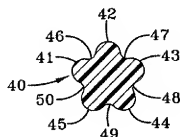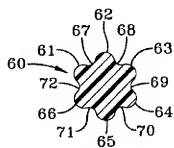
[0003] Known turf reinforcement mats in the art are typically fabricated in one of the following three ways: (1) polymer monofilament or natural organic fibers are stitch bonded together; (2) polymer monofilament can be fused with netting or (3) polymer monofilaments are woven into erosion control structures.

[0004] The patent literature does include several attempts at producing a polymeric geotextile. For example, U.S. Pat. No. 3,934,421 discloses a matting comprising a plurality of amorphous thermoplastic filaments used for stabilizing road beds. The thermoplastic may be any melt-spinnable polymer, which is spun into loops about 10 times the diameter of the filament. Matting is laid flat on the ground where repeated traffic thereon sinks the matting below the surface. The thickness of the matting tends to fill with sediment thereby stabilizing the surface. The matting may also be used for drainage in wet road beds. The porosity of the matting acts as a moisture conduit, draining excess moisture into an otherwise provided adjacent drainage area. It is briefly noted that the filaments with a non-round cross section have a greater load bearing capacity than filaments with round cross sections. Hence, the thickness of a mat for a given load may be decreased when using non-round filaments relative to the load capacity of round cross section filaments.

[0005] U.S. Pat. No. 4,181,450 discloses an erosion control matting having an open mesh reinforcing lattice over which a plurality of continuous melt-spun polymer filaments are overlaid and interlocked with the lattice. This structure is positioned over a fibrous backing member intended to capture and retain soil. The polymers contemplated include polyolefins, polyesters, and polyamides.

[0006] U.S. Pat. No. 4,329,392 discloses a multilayer netting for hydraulic engineering and erosion control. One layer of the matting is a "gripper layer" containing melt-spun polymer filaments of a larger diameter fused to a plurality of intersecting melt-spun polymer filaments of a smaller diameter. The gripper layer is placed on and reaches into fine sediment particles, thereby interlocking with the surface to be protected from erosion. A "grain rearrangement inhibiting" fiber layer is interspersed in the voids of the gripper layer, and acts as a filter prevent escape of the finest particles.

[0007] U.S. Pat. No. 4,472,086 discloses a geotextile fabric comprising first and second groups of synthetic threads, the two groups disposed essentially perpendicular to one another. A third group of threads stitch-bonds the first two groups together loosely. Use of the geotextile fabric as asphalt road repair is disclosed.

[0008] U.S. Pat. No. 5,182,162 discloses a self-bonded non-woven web and thermoplastic net-like web composite comprising at least one layer of fibrous non-woven web, which itself includes radially disposed filaments and at least one layer of aligned thermoplastic elements. The fibers can be made from a variety of polymers including polyolefins such as polyethylene, polypropylene and polyesters, and are made by extruding through spinnerettes having cross sections that can be circular, elliptical, or tri-lobal. The net-like webs disclosed therein are suitable for use as a geotextile or agricultural ground cover and useful in controlling erosion.

[0009] U.S. Pat. No. 5,851,089 discloses a geogrid composed of multiple layers of flexible mesh structures. The layers are offset from one another such that the mesh openings are not superimposed. The multiple layers are fastened to one another, and the multilayer structure is stretched in either one direction, i.e., machine direction, or in two orthogonal directions, i.e., machine direction and transverse direction. Gaps in the resulting geogrid are of various sizes, ensuring that fill sediment of various sizes may infiltrate and firmly hold the geogrid in place. The geogrid is useful in reinforcement of paved and unpaved roads, and in preventing erosion and stabilizing fill material.

[0010] U.S. Pat. No. 6,171,984 discloses a meshwork used for erosion control and soil stabilization, wherein two sets of strands, orthogonally disposed to one another, are connected with at least one set of tying strands and a bonding agent. The strands may be made of thermoplastic or glass fibers. Use of fiberglass in the geosynthetic material improves its resistance to environmental and biological wear.

[0011] While attempts have been made heretofore to provide a turf reinforcement mat having improved drainage capability and tensile strength, the art has not provided a mat that provides improved revegetation, erosion protection and water quality on slopes and in channels.

BRIEF SUMMARY OF THE INVENTION

[0012] It is therefore, an aspect of the present invention to provide a turf reinforcement mat which promotes improved revegetation, provides erosion protection and improved water quality on slopes.

[0013] It is another aspect of the present invention to provide a turf reinforcement mat employing a polymer filler comprising a multi-dimensional fiber, providing an increase in surface area.

[0014] It is yet another aspect of the present invention to provide a method for erosion control and revegetation facilitation employing the turf reinforcement mat of the present invention.

[0015] At least one or more of the foregoing aspects, together with the advantages thereof over the known art relating to turf reinforcement mats, which shall become apparent from the specification which follows, are accomplished by the invention as hereinafter described and claimed.

[0016] In general the present invention provides a turf reinforcement mat comprising at least one polymer net layer; a non-woven mat comprising a plurality of multi-dimensional polymer fibers; and, a polymer yarn, stitching the net layer to the non-woven mat.

[0017] The present invention also includes a method for erosion control and revegetation facilitation comprising providing a turf reinforcement mat comprising at least one polymer net layer; a non-woven mat comprising a plurality of multi-dimensional polymer fibers; and, a polymer yarn, stitching the net layer to the non-woven mat; laying the turf reinforcement mat on a section of ground to be reinforced; securing the turf reinforcement mat to the ground; distributing soil and seed onto the turf reinforcement mat such that the section of ground is quickly revegetated and thereby protected from further erosion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is an exploded view depicting three layers of a turf reinforcement mat, according to the present invention, and their orientation;

[0019] FIG. 2 is a perspective view of a turf reinforcement mat, according to the present invention;

[0020] FIG. 3 is a perspective view of a portion of a multi-dimensional filament, forming the mat layer of a turf reinforcement mat;

[0021] FIG. 3A is a cross-sectional view of the multi-dimensional filament of FIG. 3; and

[0022] FIGS. 4-6 are cross-sectional views of alternative multi-dimensional filaments, that can be employed to form the mat layer of a turf reinforcement mat.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The present invention generally relates to geotextile fabrics used to prevent erosion of exposed surfaces and to facilitate the revegetation of a previously eroded surface. Such an article is commonly termed a turf reinforcement mat (TRM). The TRM of the present invention comprises two polypropylene nets that form the top and bottom with a polymer fiber filler. A polymer yarn is used to stitch the fiber and nets together.

[0024] With reference to FIG. 1, the TRM of the present invention, indicated generally by the numeral 10, is depicted in exploded fashion revealing a first, or upper net 11, a second, or lower net 12 and a non-woven mat 13 of fiber filler material, which is located between the first and second nets. The first and second nets are made of one or more thermoplastic polymers. The polymers used in the net layer may include polyolefins, polyesters, polyamides and blends thereof, with polypropylene being preferred. The net layers have an open grid pattern of squares or rectangles, from about 0.625 to 7.62 cms per side, with 1.27 to 5.08 cms preferred. While the preferred embodiment of TRM 10 comprises first and second nets, it is within the scope of the present invention to provides TRM's using only one of the first or second nets, with the non-woven mat 13.

[0025] Current fibers used in the construction of TRM's are round or oval in shape. The fiber filler 13 of the TRM of the present invention consist of multi-dimensional fibers,

indicated generally by the numeral 15 in FIG. 3A. The fiber 15 is characterized herein as multi-point, multi-lobal or multi-dimensional and as depicted in FIG. 3A, provides three separate points or edges, 16, 17 and 18 and three grooves or channels 19, 20 and 21, between the points. Due to the geometric orientation of the fiber there is an increase in surface area with grooves/channels along the fiber. 15. The fibers 15 provide a minimum of three points but are not limited to three when viewing a cross-section of the fiber. With reference to FIGS. 4-6 for instance, alternative fibers 30, 40 and 50, respectively are depicted. Fiber 30 provides four edges or points, 31-34 and four channels, 35-38. Fiber 40 provides five edges or points, 41-45 and five channels, 46-51. Fiber 60 provides six edges or points, 61-66 and six channels, 67-72. For purposes of discussion herein, reference shall be made to the fiber 15, with the understanding that it is representative of a fiber having a multipoint geometric shape and that practice of the present invention is not limited to the specific form of fiber having three edges and three channels.

[0026] The fiber 15 is extruded via a die that forms the multipoint geometric shape. This shape is made in the extrusion process of the fiber. The unique geometric orientation-multipoint cross-section of the fiber captures sediment 75, (FIG. 3A) and water, which assist in greater vegetation establishment. The sediment and moisture is captured in the grooves/channels (16/19 etc.) of the fiber, which enhances seed germination and root establishment. The fiber allows for greater degree of crimp amplitude due to the geometric orientation of the fiber, which in turn provides interlocking of fibers within the matrix of the TRM. This combination along with a 40 percent greater surface area allows for a loftier product when compared to the standard monofilament fiber products. Resiliency data showed a 10 percent increase over the standard round or oval monofilament. Increased loft for ease of plant growth is essential in a TRM's functionality. The TRM of the present invention 10, revealed seed germination improvements of 30 to 40 percent over the standard and commonly used monofilament fiber TRM when tested in an independent third party lab. In bench-scale shear test, a partial vegetated plot using the TRM 10 revealed a 17 percent improvement.

[0027] The fiber 15 is polymer based, such as polyolefins, polyesters, polyamides and blends thereof, with polypropylene being preferred. The fiber 15 is extruded through a die that forms the unique multidimensional shape, at temperatures in excess of 400° F. (204° C.), that provides the multipoint cross-sectional fiber. The fiber is extruded through a water quench bath at temperatures of 70° C. The fiber is then pulled through several blowers and dryers to remove the excess water from the channels of the fiber. The fiber is then drawn into the oven at temperatures of 280+/–3° C. and draw ratio of 6.5/1. Each fiber is one continuous strand (minimum of 160 holes per die) which is wound up on a winder to form a package or spool. Deniers of the fiber 15 range from about 300 (333 decitex) to about 2000 (2222 decitex) with from about 500 (555 decitex) to about 1100 (1222 decitex) being preferred, irrespective of the actual cross-sectional geometry. It is to be appreciated that the drawings depict an idealized multipoint cross-section for the fibers, where each edge or lobe, e.g., 16, 17, 18, and channel e.g., 19, 20 and 21, is uniform. In reality, the edges and channels are not symmetrical or sharply defined, as a result

of quenching; however, the fibers do have distinct edges and channels, so as to provide a multi-dimensional geometry.

[0028] In a secondary process, the fiber from several packages forms a tow line that is fed through a mechanical crimper and cutter. The crimp box pressure is set at 0.5+/– bar and cutting wheel spacing of 4.6 inches (11.68 cm). In the practice of this invention, the individual polymer fibers 15 are cut to a length of from about 2 inches (5 cm) to about 12 inches (30 cm), with from about 3 inches (7.6 cm) to about 7 inches (17.8 cm) being preferred. The cut fiber is dumped into a hopper that feeds into a Meyer machine. The fiber is sandwiched between first and second nets, 11 and 12. The first and second nets are stitched together using polypropylene, or other, yarn 80, 81 (FIG. 2), stitching with a needle spacing of about 3 inches (7.62 cm) between 80 and 81, except at selvages, which is 1 inch (2.54 cm). Approximate dimensions between stitches 82 and 83 ranges between about 1 to 2 inches (2.54 to 5.08 cm). It is to be appreciated that other spacings are within the scope of the invention, as stitching is not a necessary limitation. The final product (TRM) is classified as a rolled good.

[0029] Specific embodiments of the present invention involve methods for preventing erosion control or promotion of revegetation of a barren or previously eroded area, or both. It is believed that the increased surface area of the filler fibers of the present invention provide a great surface area on which runoff water can drain without damaging, i.e., eroding, the underlying soil. Further, the irregularly shaped voids of the present turf reinforcement mat provide ample space into which sediment, soil and seed, if any, can fall, thereby holding down the mat as well as facilitating its incorporation into/onto the surface to be protected.

[0030] For example, the present invention includes a method for erosion control and revegetation facilitation which comprises providing a turf reinforcement mat comprising at least one polymer net layer; a non-woven mat comprising a plurality of multi-dimensional polymer fibers; and, a polymer yarn, stitching the net layer to the non-woven mat; laying the turf reinforcement mat on a section of ground to be reinforced; securing the turf reinforcement mat to the ground; distributing soil and seed onto the turf reinforcement mat such that the section of ground is quickly revegetated and thereby protected from further erosion.

[0031] A series of performance-related index tests have been developed by the Erosion Control Technology Council (ECTC) to make rolled erosion control product (RECP) testing more cost-effective and time-efficient. Using the turf reinforcement mats of the present invention as RECP's, these testing methods were employed for RECP characterization tests which demonstrates efficacy of the invention. First, a brief background on RECP characterization, is provided as follows.

[0032] Soil Loss and The Soil Loss Ratio. When used on slopes, the primary consideration of RECP systems is their ability to reduce soil loss caused by raid and immediate runoff. Soil loss ratio is equal to the reduction in soil loss when using a specific RECP system compared to the comparable bare soil (control) condition.

[0033] Permissible Shear Design. Flowing water in channels imposes shear stress on the sides and bottom of the channel. In the permissible shear stress of an RECP used to

line the channel is greater than the imposed shear, the lining is considered to provide acceptable erosion resistance.

[0034] Mulching and RECPs Longevity. RECPs often are used to provide short-term mulching, along with erosion protection, aimed at nurturing vegetation growth. As a result, there is a need to evaluate the effectiveness of an RECP in nurturing initial seed germination. Additionally, vegetation may require varying times to develop sufficiently to provide significant erosion protective cover. Times may range from 6 weeks in humid environments to several years in arid conditions. Some RECPs are required to provide permanent turf reinforcement. In all cases the RECP must be shown to have the appropriate longevity.

[0035] Testing Approach

[0036] ECTC's Slope Erosion Test. The ECTC test method titled, *"Standard Index Test Method for the Determination of Unvegetated Rolled Erosion Control Product (RECP) Ability to Protect Soil from Rain Splash and Associated Runoff Under Bench-Scale Conditions"* establishes the procedures for evaluating the ability of Rolled Erosion Control Products (RECPs) to protect soils from rain splash and immediate runoff-induced erosion. The critical element of protection measured is the ability of the RECP to absorb the impact force of raindrops, thereby reducing soil particle loosening through "splash" mechanisms. The test method utilizes a laboratory-scale testing apparatus, rather than full-scale field simulation.

[0037] Apparatus and Procedure. 8 inch diameter (20.3 cm), 4 inch (10.2 cm) deep pots containing both bare and RECP-protected soil are positioned in an incline structure comprised of three adjacent "runoff ramps" each measuring 35 inches (90 cm) long by 10 inches (25.4 cm) wide and having an opening at their lower ends to accommodate recessed pots. The entire incline structure is exposed to simulate rainfall causing both rainfall and runoff to erode the soil-filled pots for 30 minutes. Rainfall is simulated using a laboratory drip-type simulator capable of creating uniform drops with a median diameter of 3.0 to 3.5 mm from a drop height of approximately 2 m and producing rainfall intensities as high as 150 mm/hr. The amount of soil that splashes or is washed out of the containers is collected and weighed. From this data, an appropriate soil loss ratio can be calculated by comparing the RECP-protected soil loss to the control for a given soil type, slope and rainfall intensity.

[0038] ECTC's Channel Erosion Test. The ECTC test method titled, *"Standard Index Test Method for Determination of Unvegetated Rolled Erosion Control Product (RECP) Ability to Protect Soil from Hydraulically-Induced Shear Stresses Under Bench-Scale Conditions"* establishes the procedures for evaluating the ability of Rolled Erosion Control Products (RECPs) to protect soils from flow-induced erosion. The test method utilizes a laboratory-scale testing apparatus, rather than full-scale field simulation.

[0039] Apparatus and Procedures. 8 inch (20.3 cm) diameter, 4 inch (10.2 cm) deep pots containing RECP-protected soil are immersed in water, and the surface is subjected to shear stresses caused by the rotation of an impeller for 30 minutes. The shear stress test apparatus includes a tank, an internal "table" to hold recessed pots, and an impeller. The impeller is mounted in the cylindrical tank so that the lower

edge of the blades is slightly above the surface of the pots. The internal table has openings that hold the pots of soil. When pots are placed in the table openings, the test surface is flush with the top of the table. The amount of soil that erodes is found from weighing the containers of saturated soil both before and after testing. Tests are commonly run at multiple (at least three) shear stress levels. From this data the

first for a B sample, followed by an A sample. Tests results have been reported in Tables I through IV. Tensile testing, reported in Table II, was conducted according to ASTM D 6818. Resiliency, reported in Table III, was conducted according to ASTM D 6524. The surface area of the Sample A product was 5.56 m^2 and the surface area of the Sample B product was 7.99 m^2, a 44% increase.

TABLE I

Germination Testing					
Property	Units	Day	Control	Sample B	Sample A
First Round of Test					
Seeds germinated per area	# per 4 sq. in. area	21	1.1	11.8	6.9
Average pit height	inch	21	0.4	2.2	1.9
Plant mass per area	mg per 4 sq. in.	21	1	10.7	9.9
Second Round of Test					
Seeds germinated per area	# per 4 sq. in. area	14	1.8	10.7	10.7
		21	4.9	13.1	10.9
Average pit height	inch	14	1.7	3.3	2.3
		21	2.3	3.6	3.4
Plant mass per area	mg per 4 sq. in.	21	7.6	17.7	18.7
Third Round of Test					
Seeds germinated per area	# per 4 sq. in. area	14	3.8	13.7	12.6
		21	3.9	14.7	14.3
Average pit height	inch	14	1.5	2.4	2.6
		21	1.8	3.2	3.3
Plant mass per area	mg per 4 sq. in.	21	10.6	31.6	28.6

shear stress associated with a critical amount of soil loss (typically 0.5 in (1.25 cm)) can be calculated. The critical shear stress is sometimes referred to as the "permissible shear stress" of the RECP.

[0040] ECTC's Mulching Test. The test method titled, "*Standard Index Test Method for Determination of Temporary Degradable Rolled Erosion Control Product (RECP) Performance in Encouraging Seed Germination and Plant Growth*" establishes the procedures for evaluating the ability of RECP's to encourage seed germination and initial plant growth. The results of the test can be used to compare RECPs and other erosion control methods to determine which are the most effective at encouraging the growth of vegetation in different climates.

[0041] Apparatus and Procedures. 8 inch (20.3 cm) diameter, 4 inch (10.2 cm) deep pots of soil are sown with seeds and then covered with an RECP. Additional containers are left uncovered as controls. The light, water, and temperature are regulated and documented. The rate of germination is measured periodically throughout the test, and the weight of vegetation is calculated by comparing the covered results to the control.

SUMMARY OF TEST RESULTS

[0042] The following ASTM tests were conducted using Samples A and B. Sample A was an existing TRM, employing round monofilament fibers for the non-woven mat. Sample B was a TRM of the present invention, employing multi-dimensional fibers for the non-woven mat. Where a control was provided, no TRM was employed over the soil. Each test provides a physical property e.g. tensile strength,

[0043] With reference to the first round of tests, after 21 days, the Sample B product showed a 71% improvement over the Sample A product for seed germinated per area. For average pit height, the improvement of Sample B over Sample A was 16% and far plant mass per area, the improvement of Sample B over Sample A was 8%.

[0044] With reference to the second round of tests, after 14 days, the Sample B product showed no improvement over the Sample A product for seed germinated per area while after 21 days, the Sample B product showed a 20% improvement over the Sample A product. For average pit height, the improvement of Sample B over Sample A was 43% after 14 days and 6% after 21 days. For plant mass per area, there was no improvement after 21 days.

[0045] With reference to the third round of tests, after 14 days, the Sample B product showed a 9% improvement over the Sample A product for seed germinated per area while after 21 days, the Sample B product showed a 3% improvement over the Sample A product. For average pit height, there was no improvement of Sample B over Sample A after 14 days and after 21 days. For plant mass per area, there was a 10% improvement after 21 days.

TABLE II

Tensile Testing			
Property	Units	Sample B	Sample A
First Round of Test			
Tensile	lbvft	md	512	465
		xmd	488	320

TABLE II-continued

Tensile Testing

Property	Units		Sample B	Sample A
		Second Round of Test		
Tensile	lb/ft	md	521	440
		xmd	467	325
		Third Round of Test		
Tensile	lb/ft	md	586	405
		xmd	516	388
		Fourth Round of Test		
Tensile	lb/ft	md	541	444
		xmd	453	320

[0046] With reference to the first round of tests, the Sample B product showed a 10% improvement over the Sample A product in tensile strength in the machine direction and a 53% improvement over the Sample A product in the cross-machine direction.

[0047] With reference to the second round of tests, the Sample B product showed an 18% improvement over the Sample A product in tensile strength in the machine direction and a 44% improvement over the Sample A product in the cross-machine direction.

[0048] With reference to the third round of tests, the Sample B product showed a 45% improvement over the Sample A product in tensile strength in the machine direction and a 353% improvement over the Sample A product in the cross-machine direction.

[0049] With reference to the fourth round of tests, the Sample B product showed a 22% improvement over the Sample A product in tensile strength in the machine direction and a 42% improvement over the Sample A product in the cross-machine direction. Overall, the average improvement was 33%.

TABLE III

Resiliency

Property	Units	Sample B	Sample A
First round of test	%	93	82
Second round of test	%	87	78

Property	Units	Sample B	Sample A
Soil Loss	SLR	0.14	0.15

[0050] With reference to the first round of tests, the Sample B product showed a 13% improvement over the Sample A product in resiliency and a 12% improvement over the Sample A product in the second round of tests, for an average improvement of 12.5%. Finally, soil loss was 7% less for the Sample B product over the Sample A product.

[0051] Finally, test sets were designed to evaluate an RECP's ability to provide channel protection for a selected soil and a range of flow-induced shear stresses. The results of the testing include the amount of soil lost at various shear stresses. From this data, an appropriate permissible shear

(tp) can be calculated by assuming a critical amount of soil loss (typically 13 mm). The results of this test are presented in Table IV.

TABLE IV

Erosion Testing

Test	Tested Materials	Test Parameters	Test Results
Shear-induced Erosion	Sample B	Silty-sand; 65–70% Vegetated	tp = 6.4 psf
	Sample A	Silty-sand; 65–70% Vegetated	tp = 6.8 psf

(Key: tp = permissible shear)

[0052] The results of Table IV indicate that Sample B had a 6% better shear stress than Sample A.

[0053] Thus it should be evident that the turf reinforcement mat and method of the present invention are highly effective in preventing erosion from exposed surfaces and promoting revegetation of previously eroded surfaces. The invention is particularly suited for erosion control and promotion of revegetation of a previously eroded land surface, but is necessarily limited thereto.

[0054] Based upon the foregoing disclosure, it should now be apparent that the use of the turf reinforcement mat described herein will carry out the objects set forth hereinabove. It is, therefore, to be understood that any variations evident fall within the scope of the claimed invention and thus, the selection of specific component elements can be determined without departing from the spirit of the invention herein disclosed and described. In particular, multi-dimensional polymer fibers according to the present invention are not necessarily limited to those having a tri-lobal cross section. Thus, the scope of the invention shall include all modifications and variations that may fall within the scope of the attached claims.

What is claimed is:

1. A turf reinforcement mat comprising:

at least one polymer net layer;

a non-woven mat comprising a plurality of multi-dimensional polymer fibers; and,

a polymer yarn, stitching said net layer to said non-woven mat.

2. The turf reinforcement mat of claim 1, wherein said multi-dimensional polymer fiber has at least three edges and at least three channels.

3. The turf reinforcement mat of claim 1, wherein said multi-dimensional polymer fiber is selected from the group consisting of polyolefins, polyesters, polyamides and blends thereof.

4. The turf reinforcement mat of claim 1, wherein said multi-dimensional fibers have a length from about 2 inches (5 cm) to about 12 inches (30 cm).

5. The turf reinforcement mat of claim 1, wherein said multi-dimensional polymer fiber has a density of from about 300 denier (333 decitex) to about 2000 denier (2222 decitex).

6. The turf reinforcement mat of claim 5, wherein said multi-dimensional polymer fiber has a density of from about 500 denier (555 decitex) to about 1100 denier (1222 decitex).

7. The turf reinforcement mat of claim 1, wherein the polymer of set net layer is selected from the group consisting of polyolefins, polyesters, polyamides and blends thereof.

8. The turf reinforcement mat of claim 1, further comprising a second polymer net layer, said non-woven mat being located between said first and second nets.

9. The turf reinforcement mat of claim 1, wherein the tensile strength of the turf reinforcement mat is at least 30% greater than the tensile strength of an otherwise identical turf reinforcement mat having round multi-dimensional polymer fibers.

10. A method for erosion control and revegetation facilitation comprising:

provided a turf reinforcement mat comprising

at least one polymer net layer,

a non-woven mat comprising a plurality of multi-dimensional polymer fibers; and,

a polymer yarn, stitching said net layer to said non-woven mat;

laying said turf reinforcement mat on a section of ground to be reinforced;

securing said turf reinforcement mat to the ground;

distributing soil and seed onto said turf reinforcement mat such that the section of ground is quickly revegetated and thereby protected from further erosion.

11. A method for erosion control and revegetation facilitation as set forth in claim 10, wherein said multi-dimensional polymer fiber has at least three edges and at least three channels.

12. A method for erosion control and revegetation facilitation as set forth in claim 10, wherein said multi-dimensional polymer fiber is selected from the group consisting of polyolefins, polyesters, polyamides and blends thereof.

13. A method for erosion control and revegetation facilitation as set forth in claim 10, wherein said multi-dimensional fibers have a length from about 2 inches (5 cm) to about 12 inches (30 cm).

14. A method for erosion control and revegetation facilitation as set forth in claim 10, wherein said multi-dimensional polymer fiber has a density of from about 300 denier (333 decitex) to about 2000 denier (2222 decitex).

15. A method for erosion control and revegetation-facilitation as set forth in claim 14, wherein said multi-dimensional fibers have a density of from about 500 denier (555 decitex) to about 1100 denier (1222 decitex).

16. A method for erosion control and revegetation facilitation as set forth in claim 10, wherein the polymer of set net layer is selected from the group consisting of polyolefins, polyesters, polyamides and blends thereof.

17. A method for erosion control and revegetation facilitation as set forth in claim 10, further comprising a second polymer net layer, said non-woven mat being located between said first and second nets.

* * * * *

APPENDIX 3

RELATED PROCEEDINGS APPENDIX

None.